TerraGraphics
Environmental Engineering, Inc.

www.terragraphics.com

**Corporate Office:**
121 S. Jackson St., Moscow, Idaho 83843
Ph: (208) 882-7858; Fax: (208) 883-3785

**Other Office Locations:**
**Kellogg, Idaho**
**Boise, Idaho**
**Helena, Montana**
**Deer Lodge, Montana**
**Las Vegas, Nevada**
**Richland, Washington**

TECHNICAL MEMORANDUM

**To:** Steve Gill, IDEQ Regional Office, Coeur d'Alene, Idaho
Bruce Wicherski, IDEQ State Office, Boise, Idaho
Eric Traynor, IDEQ Regional Office, Boise, Idaho

**CC:** Kyle Steele, City of Moscow, Idaho
Bill Belknap, City of Moscow, Idaho
Alisa Anderson, City of Moscow, Idaho

**From:** On behalf of the City of Moscow, Idaho
Jon Munkers, TerraGraphics, Boise, Idaho
Rachel Gibeault, TerraGraphics, Boise, Idaho

**Date:** August 3, 2015

**Subject:** **Risk Evaluation for 217 & 317 East 6th Street, Moscow, Idaho**

# 1 Introduction

This Risk Evaluation (RE) has been prepared for the 6th and Jackson Site located at 217 and 317 East 6th Street in Moscow, Idaho (or "the Site"), in accordance with the Idaho Risk Evaluation Manual (REM) (IDEQ 2004). The purpose of this RE is to assess potential risk and hazards to human health and the environment from exposure to contaminated media at the Site. Section 2 below describes the background of the Site. Section 3 describes the Contaminants of Concern (COCs) identified in the Phase II Environmental Assessment Report for 217 & 317 East 6th Street Moscow, Idaho (TerraGraphics 2015). Uncertainty analyses, conclusions, and further recommendations are presented in Sections 5 and 6.

# 2 Site Background

Historical documents from 1928 through 1960 depict a grain warehouse, flour mill, feed mill, and retail grain sales on site, with a gap between the buildings for the railroad tracks. In 1971, the flour mill is gone, bulk fertilizer tanks are present in the north central portion of the property, and the railroad easement is still visible. Photographs from 2008 show commercial storage of pesticides inside the old grain warehouse.

The U.S. Environmental Protection Agency (USEPA) awarded the City of Moscow a Brownfields Assessment Coalition Grant (for hazardous substances contamination and petroleum

contamination) in August 2010. The City is using the USEPA grant funds to conduct environmental assessments for multiple Brownfield properties along a former railroad/industrial corridor, future industrial park property, and other negatively impacted and/or stigmatized areas. The Greater Moscow Area Coalition Brownfield Project includes the 6th and Jackson site.

Strata Inc. (Strata) conducted Phase I Environmental Site Assessments (ESAs) in 2008 and 2010 which identified bulk storage of agricultural chemicals and a small heating oil underground storage tank (UST) in the eastern area of the site as recognized environmental conditions (RECs; Strata 2008 and 2010). Tetra Tech, Inc. (Tetra Tech) conducted a Phase II ESA in 2012 for soil and groundwater contamination based on these RECs (Tetra Tech 2013).

Tetra Tech's Phase II ESA findings indicate that DDT and dieldrin in the central portion of the site were contaminants of concern (COCs) in soil that exceeded their corresponding Idaho Initial Default Target Levels (IDTLs) listed in Appendix A of IDEQ's REM (IDEQ 2004). Results from the Tetra Tech Phase II ESA groundwater sampling indicate the IDTLs are exceeded for nitrite/nitrate as nitrogen at all wells except S2-MW-01 (located in the southeast of the site), arsenic at all wells, and lead at S2-MW-03 (located in the northwest of the site).

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) conducted follow-up sampling in the central portion of the site in November 2013 to evaluate DDT and dieldrin concentrations in various soil depths (TerraGraphics 2014). Dieldrin was not detected above the reporting limit. DDT, however, exceeded the IDTL in soil depths ranging from 0-48 inches below ground surface (bgs).

In December 2014, TerraGraphics collected additional soil samples from borings in the central and western portions of the site to further delineate nutrients, pesticides, and metals. TerraGraphics also installed two additional monitoring wells and collected groundwater samples from all six onsite wells. The Phase II Environmental Assessment Report (TerraGraphics 2015) concluded the following for the site.

## 2.1 Site Soil

- Arsenic, mercury, and lead exceeded the IDTLs. However, arsenic and mercury concentrations are below background levels for eastern Washington as found in the Washington State Department of Ecology's Natural Background Soil Metals Concentrations in Washington State (Ecology 1994). Lead concentrations are below the USEPA regional screening level (RSL). Therefore, these analytes are eliminated from further evaluation.
- DDT concentrations in soils were not above reporting limits. Dieldrin remains at the site but did not exceed the IDTL during this sampling event.
- Ammonia and nitrate were found in soils at concentrations exceeding the IDTLs. Nitrite was detected in one soil sample (BH-3 in the southwestern portion of the property) above the IDTL. Total Kjehldahl Nitrogen (TKN) and total phosphorus were detected throughout the central and western portions of the site; however, there are no IDTLs from that area.
- Naphthalene was detected in one soil sample (BH-7 southwest of the bulk fertilizer tanks) at 0.405 mg/kg, which exceeded the IDTL of 0.12 mg/kg.

## 2.2 Site Groundwater

In 2012, Tetra Tech calculated the groundwater gradient to be towards the northwest. The 2014 assessment calculated the groundwater gradient to be towards the west and that the groundwater gradient in the western portion of the site is shallow with almost no change in water levels. Although the general gradients are similar, the data show that the gradient may fluctuate seasonally.

- DDT and dieldrin were not detected in the groundwater samples. Previous sampling showed MW-1 was the only well to show DDT concentrations; however, the concentration was qualified as an estimate and was below the IDTL. Therefore, these analytes are eliminated from further evaluation.
- Ammonia, TKN, and phosphorus (all without IDTLs) were greatest near the former bulk fertilizer tanks and the northwest corner of the site. Ammonia and phosphorus were detected in all wells. TKN was only detected in MW-5, the well located near the bulk fertilizer tanks, and MW-6, the well in the northwest corner.
- Nitrate concentrations exceed the IDTL in the western third of the site. The highest nitrate concentration is in the northwest corner of the site (MW-6). However, nitrate was found in all site wells.
- Arsenic concentrations exceed IDTL. Comparative background concentrations are not available.

# 3 Conceptual Site Model

A Conceptual Site Model (CSM) describes Exposure Point Concentrations (EPCs), release mechanisms, exposure routes, and receptors at the site. The purpose of a CSM is to describe the routes or pathways by which humans may be exposed to contaminants at the site. Figure 1 displays the sources of COCs (DDT and dieldrin in soil; ammonia nitrate, and nitrite in soil and groundwater; naphthalene in soil; and arsenic in groundwater), release and transport mechanisms, exposure routes, and potentially exposed receptor scenarios.

A complete exposure pathway consists of four necessary elements: i) a source and mechanism of chemical release to the environment, ii) an environmental transport medium for a released chemical, iii) a point of potential human contact with the impacted medium (referred to as the exposure point), and iv) an exposure route (e.g., soil ingestion) at the exposure point. The CSM for the site, based on information that has been collected to date, is discussed in the sub-sections below.

## 3.1 Exposure Point Concentrations

TerraGraphics developed EPCs for each COC in soil and groundwater to quantify exposures to humans at the Site. The EPC represents the concentrations to which a receptor may be exposed over a long period of time as the individual randomly moves over the Site. TerraGraphics determined the EPCs for both mediums: subsurface soil and groundwater using data collected from the site under an approved QAPP since 2012.

When there are six or more detections in the data set, the EPC is the 95th percent upper confidence limit (95% UCL) of the mean concentration for each medium, calculated with ProUCL software (version 5.0.00 [USEPA 2013]). ProUCL incorporates undetected values by assigning values based on the distribution of detected values. ProUCL uses this substituted data set to determine the overall data distribution. The ProUCL software makes UCL recommendations based on the distribution of data. The UCL recommended by ProUCL is used as the EPC when six or more detected values exist.

When the data set consists of fewer than six detections, the maximum concentration is used as the EPC. Table 1 at the end of this memorandum presents the calculated 95% UCL for site COCs, where applicable, that were used in the Risk Evaluation calculations. Appendix A provides the 95% UCL calculations.

## 3.2 Release Mechanisms

Figure 1 provides a visual example of the CSM. The COCs are found in the soil due to leaks and spills from onsite storage (ASTs), onsite chemical mixing and handling, and onsite use. Secondary releases have occurred that resulted in spreading COCs to other areas of the site and to local groundwater via aerial deposition, physical disturbance, degradation through precipitation and migration, and degradation through infiltration and leaching.

## 3.3 Exposure Routes

The Site is currently vacant; however, potential future site uses include commercial businesses on the ground level and residential sites starting on the second floor. Current and future Site uses are likely to result in contact with subsurface soils while groundwater resources will not be developed at the Site. Completed exposure pathways were evaluated as part of this Risk Evaluation.

### *3.3.1 Dermal Contact and Ingestion*

Future development activities may result in direct contact with subsurface soils by Site remediation and construction workers. Dermal contact and ingestion of soil particulates are complete pathways at the site.

### *3.3.2 Inhalation*

Remediation and development activities that could stir up the soil would result in remediation and construction workers coming in contact with site COCs. Additionally, due to the volatile nature of some of the COCs, any future occupational uses could result in completion of the indoor air inhalation pathway. Therefore, the inhalation exposure pathway for soils is considered complete.

### *3.3.3 Groundwater*

Groundwater elevations (expressed in feet above mean sea level) at each monitoring ranged from 2,560.43 at MW-1 and MW-6, to 2,560.62 at MW-1. The groundwater gradient is very shallow in the western area of the site with almost no change in water levels. In the southeastern area of

the site, the gradient is $1.05x10^{-3}$ towards the west. In the northeastern area of the site, the gradient is steeper, $2.11x10^{-3}$ towards the northwest. Past hydraulic gradients have been toward the northwest suggesting the gradient may vary somewhat seasonally (TerraGraphics 2015).

Future site use does not include the use of groundwater as a drinking water source or for irrigation. Additionally, surrounding properties are mainly commercial properties that do not use the shallow groundwater for drinking water or irrigation. However, some site COCs could migrate off site; therefore, the groundwater ingestion pathway is partially complete following the Ground Water Quality Rule (IDAPA 58.01.011).

This rule establishes minimum requirements for protection of ground water quality through standards and an aquifer categorization process. The requirements of this rule shall serve as a basis for the administration of programs which address ground water quality. This rule does not in and of itself create a permit program.

## 3.4 Receptors

TerraGraphics completed a risk evaluation that considers the Residential (child and age-adjusted), Non-Residential, and Construction Worker scenarios based on current and future commercial/residential uses of the site and future construction/development of the site. TerraGraphics completed risk and hazard calculations for the COCs using the standard set of equations and default settings provided by the REM software (IDEQ 2004).

For combined exposure to all carcinogens and routes of exposure (ROEs), individual excess lifetime cancer risk (IELCR) must be less than or equal to $1.0x10^{-5}$ (acceptable Risk) for a receptor at a reasonable maximum exposure. Additionally, the summation of hazard quotients (HQs) for all chemicals that have noncarcinogenic health effects and ROEs must be less than or equal to 1.0 (acceptable Hazard Index [HI]).

# 4 Risk Evaluation-1

TerraGraphics used the 95% UCL, where applicable, or the highest recorded concentration of COCs found at the Site to estimate cancer and noncancer risks associated with site exposures. For all three receptor scenarios, TerraGraphics used soil concentrations collected from the entire site for sub-surface samples. Although Tetra Tech separated surface soils (0-6 inches bgs) from sub-surface soils (greater than 6 inches), TerraGraphics, with the recommendation from IDEQ, defined surface soils as 0-24 inches bgs and sub-surface soils as greater than 24 inches bgs for DDT samples only. Otherwise, TerraGraphics defined surface soils as 0-5 feet bgs and sub-surface soils as greater than 5 feet bgs. Therefore, all calculated 95 percent UCL concentrations were entered for surface and sub-surface soils. For exposure factors, fate and transport parameters, and decay rates, TerraGraphics used software default values.

Based on this evaluation, the estimated cancer risk for the resident-child receptor was $7.60x10^{-7}$, for the resident-age-adjusted receptor was $1.13x10^{-6}$, for the non-resident receptor was $4.55x10^{-8}$, and for the construction worker receptor was $5.57x10^{-9}$; all of which are below the acceptable risk level (Table 2).

Estimated noncancer risk for the resident-child receptor was 106, the estimated noncancer risk for the resident-age-adjusted receptor was 20.0, and the estimated noncancer risk for the non-residential receptor was 2.88. These HIs exceed the acceptable noncancer risk level and ammonia is the main contributor to these exceedences. The estimated noncancer risk for the construction worker receptor, however, was 0.581, which is acceptable (Table 2).

The REM calculated Remedial Action Target Levels (RATLs) for the Residential and Non-residential receptors. Construction Worker RATLs were not calculated since they were below the acceptable Risk and HI. The following COCs have suggested cleanup levels for surface soil and sub-surface soil based on available toxicity and/or physical-chemical properties for the Resident and Non-resident receptors: ammonia, DDT, dieldrin, and naphthalene. Based on future site use, TerraGraphics recommends using the RATLs as cleanup thresholds for these constituents.

Ammonia in groundwater also had a calculated RATL. Based on future site use, TerraGraphics recommends using the RATLs as cleanup thresholds for these constituents. Attachment A contains an output of RATLs for based on the REM calculations. For nitrate and nitrite, TerraGraphics recommends using the USEPA Maximum Contaminant Level (MCL) (USEPA 2015).

# 5 Uncertainty

Estimating and evaluating health risks from exposure to environmental chemicals is a complex process with inherent uncertainties. Uncertainty reflects limitations in knowledge and simplifying assumptions that must be made in order to quantify health risks. The uncertainty analysis plays a key role in understanding the implications for the remedy and devising strategies to achieve a safe, effective, and efficient remedy in the cleanup process.

In this assessment, uncertainties relate to (1) the development of media concentrations and assumptions about exposure, (2) the assumptions about toxicity, and (3) the characterization of health risks. This section qualitatively evaluates each of these potential sources of uncertainty to determine the likely degree of uncertainty associated with the risk estimates, and whether the uncertainty is more likely to over- or under-estimate risk.

In general, when quantifying exposure and toxicity, REM risk assessment procedures are conservative in order to protect human health. REM risk assessment procedures are more likely to indicate that chemicals exceed target risk goals when health risks may actually be negligible, rather than indicate that chemicals are not a health risk when in fact they may be. This conservative approach is used to ensure that false-negative conclusions about health risk do not occur.

Measurement errors and random and/or systematic errors arise from the inability to measure variables precisely and accurately (e.g., field equipment and laboratory protocols), or because the quantity being measured varies spatially or temporally. Basic methodological (laboratory processing and equipment) errors were less of a problem for the data set in this Risk Evaluation, given the reliance on standardized protocols and other quality assurance/quality control dictated criteria. The principal uncertainties with the data used in this Risk Evaluation lie more with spatial and temporal errors in sampling.

It is not possible to sample every square inch of potentially impacted media at a site. Instead, a limited number of samples were obtained to represent the contaminant characteristics of a larger medium. This introduces uncertainty in the development of media concentrations. The sampling strategies were, in general, designed to prevent underestimation of media concentrations, thus avoiding an underestimation of human health risks.

In addition to the available data and the spatial and temporal error, there is inherent uncertainty in calculating an EPC. First, there are a variety of methods for determining the UCL of a population. In this Risk Evaluation, the recommended UCL calculated by ProUCL (version 5.0.00) was used, even if it was not a 95 percent UCL. Difficulty in estimating underlying data distributions can also occur with a large number of non-detected results. When there were fewer than six detected sample results for a specific medium, the maximum concentration was used as the EPC. This is likely an overestimate of the exposure, but again, is conservative in protecting human health.

# 6 Conclusion

Based on a screening evaluation, nutrients, DDT and dieldrin, naphthalene, and arsenic were identified as COCs in soils and groundwater at the Site. EPCs were defined based on the UCLs of the mean concentrations, or in instances where too few data points were available, the maximum concentration of each COC within soil and groundwater. These EPCs were compared to REM carcinogenic and noncarcinogenic cleanup levels to calculate risk. Specific pathways were evaluated quantitatively and qualitatively based on the CSM to evaluate carcinogenic and noncarcinogenic risks. Soil and groundwater poses unacceptable noncarcinogenic risk primarily due to ammonia.

# 7 References

Idaho Administrative Procedures Act (IDAPA) 58.01.011. Ground Water Quality Rule. Available at http://adminrules.idaho.gov/rules/current/58/0111.pdf, accessed May 28, 2015.

Idaho Department of Environmental Quality (IDEQ), 2004. Idaho Risk Evaluation Manual. 1410 North Hilton, Boise, Idaho 83706, April.

Strata, 2008. Environmental Site Assessment – Phase I ESA, 217 West 6th Street, Moscow, Idaho 83843. Prepared for Mr. Duane Breslford, Corporate Pointe Developers, June 9.

Strata, 2010. Phase I Environmental Site Assessment 217 West Sixth Street, Moscow, Idaho. Prepared for Moscow Urban Renewal Agency, August 5.

TerraGraphics Environmental Engineering, Inc. (TerraGraphics), 2014. Technical Memorandum from TerraGraphics to the City of Moscow re. Analysis for Brownfields Cleanup Alternatives (ABCA) Update for 317 W. 6th Street, Moscow, Idaho. January 17.

TerraGraphics, 2015. Final Phase II Environmental Site Assessment Report for 217 & 317 East 6th Street Moscow, Idaho. Prepared for the City of Moscow. April 2.

Tetra Tech, 2013. Final Phase II Environmental Site Assessment 217 West 6th Street Moscow, Idaho.

U.S. Environmental Protection Agency (USEPA), 2013. ProUCL Version 5.0.00 Statistical Software for Environmental Applications for Data Set with and without Nondetect Observations. Prepared for USEPA Office of Research and Development, USEPA/600/R-07/041. Software released September 2013. Available at http://www2.epa.gov/land-research/proucl-software, accessed May 27, 2015.

USEPA, 2015. Regional Screening Level (RSL) Resident Soil Table. January. http://www.epa.gov/region9/superfund/prg/, accessed February 12, 2015.

## Table 1. Site Contaminants of Concern Concentrations

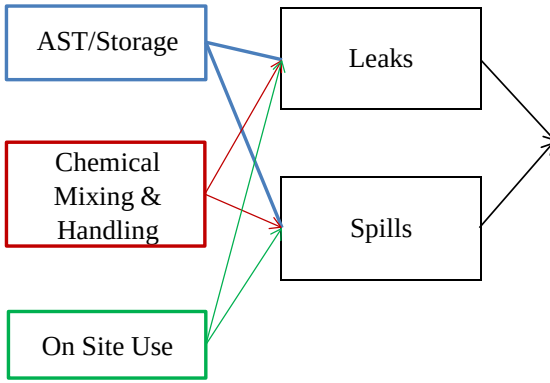
| Matrix | Analyte | IDTL[a] | Critical Pathway[b] | Site Wide (calculated 95% UCL) |
|---|---|---|---|---|
| Soil (mg/kg) | DDT surface (0-24 inches) | 0.403 | GWP | **1.678** |
| | DDT sub-surface(<24 inches) | 0.403 | GWP | 0.0415 |
| | Dieldrin | 0.00133 | GWP | **0.011**[c] |
| | Ammonia | 4.15 | SS | **424.6** |
| | Nitrate | 18.4 | GWP | 16.07 |
| | Nitrite | 1.84 | GWP | **3.11** |
| | Naphthalene | 0.12 | VI | **0.405** |
| Water (mg/L) | Ammonia | Not established | Not established | 81.13 |
| | Nitrate | 10.0 | I | **34.26** |
| | Nitrite | 1.0 | I | 0.451 |

Notes:
Concentrations in **BOLD** exceed the IDTL.
a = Initial Default Target Level (IDTL) is established in the Risk Evaluation Manual (IDEQ 2004).
b = The exposure pathway that is likely to be affected by the contaminant as established in the Risk Evaluation Manual (IDEQ 2004).
c = Concentration is from Tetra Tech, 2013. Final Phase II Environmental Site Assessment.
95% UCL = 95th percentile upper confidence limit calculated using site data gathered from 2012 through 2014. USEPA's ProUCL software (version 5.0.00). Dieldrin in soil, naphthalene in soil, and nitrite in soil and groundwater had too few data points to calculate a UCL; therefore, the highest recorded concentration is represented.
bgs = below ground surface
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
GWP = groundwater protection via soils leaching to groundwater
SS = subsurface soils via volatilization to indoor and outdoor air
I = ingestion of water on or off site
VI = vapor intrusion

## Table 2. Summary of Cumulative Risk and Hazard Index

| Receptor | Calculated Risk | Calculated Hazard Index |
|---|---|---|
| Child | $1.02 \times 10^{-6}$ | 106 |
| Age-adjusted | $1.51 \times 10^{-6}$ | 20.0 |
| Non-residential | $6.66 \times 10^{-8}$ | 2.88 |
| Construction Worker | $8.38 \times 10^{-9}$ | 0.582 |
| Acceptable Risk or Hazard Index | $1.0 \times 10^{-5}$ | 1.0 |

**DRAFT - 217 & 317 East 6th Street, Moscow, Idaho Conceptual Site Model**




| Primary Source | Release/ Transport Mechanisms | Potential Secondary Sources | Release/ Transport Mechanisms | Potential Exposure Route | | Potentially Exposed Receptor Scenarios: Human Health – Resident-Child | Resident-Age Adjusted | Non-resident | Construction Worker |
|---|---|---|---|---|---|---|---|---|---|
| AST/Storage | Leaks | Soil | Aerial Deposition | Dermal Contact | | X | X | X | X |
| Chemical Mixing & Handling | Spills | | Physical Disturbance/ Tracking | Ingestion: | Particulates | X | X | X | X |
| On Site Use | | | Degradation/ Precipitation & Migration | | Water | / | / | / | / |
| | | | Degradation/ Infiltration & Leaching | Inhalation | | X | X | X | X |

Key: X = complete pathway
/ = partially complete pathway

# Attachment A

## Risk Evaluation Supporting Documents

# RE-1 SUMMARY OF CUMULATIVE RISK AND HAZARD INDEX

| Routes of Exposure | RECEPTOR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | RESIDENTIAL | | | | NON-RESIDENTIAL | | CONSTRUCTION WORKER | |
| | CHILD | | AGE-ADJUSTED | | | | | |
| | Risk | Hazard Index | Risk | Hazard Index | Risk | Hazard Index | Risk | Hazard Index |
| **Surface Soil:** Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | 1.00E-06 | 9.63E-01 | 1.48E-06 | 1.88E-01 | 6.60E-08 | 5.45E-01 | 8.38E-09 | 5.82E-01 |
| **Subsurface Soil:** Indoor Inhalation of Vapor Emissions | 2.20E-08 | 1.03E+02 | 3.71E-08 | 1.92E+01 | 5.69E-10 | 2.29E+00 | Not Applicable | Not Applicable |
| **Groundwater:** Indoor Inhalation of Vapor Emissions | NA | 1.93E+00 | NA | 6.51E-01 | NA | 4.42E-02 | Not Applicable | Not Applicable |
| **Soil-Vapor:** Indoor Inhalation of Vapor Emissions from Soil and/or Groundwater | NA | NA | NA | NA | NA | NA | Not Applicable | Not Applicable |
| **Site Risk** | **1.02E-06** | | **1.51E-06** | | **6.66E-08** | | **8.38E-09** | |
| **Site Hazard Index** | | **1.06E+02** | | **2.00E+01** | | **2.88E+00** | | **5.82E-01** |
| RATL-1/RATL-2 Required? | NO | YES | NO | YES | NO | YES | NO | NO |

**Notes:**
**NA: Not applicable because the chemical is not a COC for the pathway (no representative concentration entered) or its properties (toxicity and/or physical-chemical) are not available.**

## RE-1 REPRESENTATIVE CONCENTRATIONS FOR RESIDENTIAL RECEPTORS

| CHEMICALS OF CONCERN | SURFICIAL SOIL | SUB-SURFACE SOIL | GROUNDWATER | SOIL-VAPOR | GROUNDWATER AND/OR SURFACE WATER PROTECTION | | |
|---|---|---|---|---|---|---|---|
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions | Representative Groundwater Concentration at the Source [mg/L] | Representative Soil Concentration at the Source [mg/kg] | Representative Groundwater Concentration at the POC [mg/L] |
| | Representative Concentration [mg/kg] | Representative Concentration [mg/kg] | Representative Concentration [mg/L] | USE OF SOIL-VAPOR DATA IS NOT ALLOWED UNDER RE-1 | | NOT USED IN CALCULATIONS | |
| Ammonia | 4.25E+02 | 4.25E+02 | 8.11E+01 | | 8.11E+01 | | |
| DDT | 1.68E+00 | 4.15E-02 | | | | | |
| Dieldrin | 1.10E-02 | 1.10E-02 | | | | | |
| Naphthalene | 4.05E-01 | 4.05E-01 | | | | | |
| Nitrate (as Sodium Nitrate) | 1.61E+01 | 1.61E+01 | 3.43E+01 | | | | |
| Nitrite (as Sodium Nitrite) | 3.11E+00 | 3.11E+00 | 4.51E-01 | | 3.43E+01 | | |

**Notes:**

## RE-1 RISK/HAZARD QUOTIENT FOR RESIDENTIAL RECEPTORS

| CHEMICALS OF CONCERN | CHILD | | | | | | | | AGE-ADJUSTED | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SURFICIAL SOIL | | SUB-SURFACE SOIL | | GROUNDWATER | | SOIL-VAPOR | | SURFICIAL SOIL | | SUB-SURFACE SOIL | | GROUNDWATER | | SOIL-VAPOR | |
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | |
| | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ |
| Ammonia | NTOX | 9.08E-01 | NTOX | 1.02E+02 | NTOX | 1.93E+00 | | | NTOX | 1.72E-01 | NTOX | 1.91E+01 | NTOX | 6.51E-01 | | |
| DDT | 6.68E-07 | 4.59E-02 | 1.36E-09 | 9.33E-05 | | | | | 9.83E-07 | 1.35E-02 | 2.30E-09 | 3.15E-05 | | | | |
| Dieldrin | 3.33E-07 | 4.86E-03 | 2.06E-08 | 3.01E-04 | | | | | 4.93E-07 | 1.44E-03 | 3.48E-08 | 1.02E-04 | | | | |
| Naphthalene | NTOX | 3.57E-03 | NTOX | 3.54E-01 | | | | | NTOX | 7.04E-04 | NTOX | 1.18E-01 | | | | |
| Nitrate (as Sodium Nitrate) | NTOX | 1.11E-04 | NTOX | NTOX | NPCP | NPCP | | | NTOX | 3.28E-05 | NTOX | NTOX | NPCP | NPCP | | |
| Nitrite (as Sodium Nitrite) | NTOX | 3.44E-04 | NTOX | NTOX | NPCP | NPCP | | | NTOX | 1.01E-04 | NTOX | NTOX | NPCP | NPCP | | |

**Notes:**

**NPCP: A physical-chemical parameter, required in the calculation of the value, is not available.**

**NTOX: The toxicity parameter(s) required in the calculation of the value, is not available.**

**NCOC: The chemical is not a COC for the pathway because it was selected, but no representative concentration was entered.**

## RATL-1 FOR RESIDENTIAL RECEPTORS

| CHEMICALS OF CONCERN | CHILD | | | | AGE-ADJUSTED | | | |
|---|---|---|---|---|---|---|---|---|
| | SURFICIAL SOIL | SUB-SURFACE SOIL | GROUNDWATER | SOIL-VAPOR | SURFICIAL SOIL | SUB-SURFACE SOIL | GROUNDWATER | SOIL-VAPOR |
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions |
| | [mg/kg] | [mg/kg] | [mg/L] | [ug/m3] | [mg/kg] | [mg/kg] | [mg/L] | [$\mu g/m^3$] |
| Ammonia | 4.25E+01 | 3.77E-01 | 3.83E+00 | NA | 2.25E+02 | 2.02E+00 | 1.13E+01 | NA |
| DDT | 3.33E+00 | 4.04E+01 | NA | NA | 4.27E+00 | 4.51E+01 | NA | NA |
| Dieldrin | 8.26E-02 | 1.33E+00 | NA | NA | 5.58E-02 | 7.90E-01 | NA | NA |
| Naphthalene | 1.03E+01 | 1.04E-01 | NA | NA | 5.23E+01 | 3.13E-01 | NA | NA |
| Nitrate (as Sodium Nitrate) | 1.31E+04 | NA | NA | NA | 4.46E+04 | NA | NA | NA |
| Nitrite (as Sodium Nitrite) | 8.22E+02 | NA | NA | NA | 2.79E+03 | NA | NA | NA |

**Notes:**
**NA: Not applicable because the chemical is not a COC for the pathway (no representative concentration entered) or its properties (toxicity and/or physical-chemical) are not available.**

# RE-1 REPRESENTATIVE CONCENTRATIONS FOR NON-RESIDENTIAL RECEPTORS

| CHEMICALS OF CONCERN | SURFICIAL SOIL | SUB-SURFACE SOIL | GROUNDWATER | SOIL-VAPOR |
|---|---|---|---|---|
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions |
| | Representative Concentration [mg/kg] | Representative Concentration [mg/kg] | Representative Concentration [mg/L] | USE OF SOIL-VAPOR DATA IS NOT ALLOWED UNDER RE-1 |
| Ammonia | 4.25E+02 | 4.25E+02 | 8.11E+01 | |
| DDT | 1.68E+00 | 4.15E-02 | | |
| Dieldrin | 1.10E-02 | 1.10E-02 | | |
| Naphthalene | 4.05E-01 | 4.05E-01 | | |
| Nitrate (as Sodium Nitrate) | 1.61E+01 | 1.61E+01 | 3.43E+01 | |
| Nitrite (as Sodium Nitrite) | 3.11E+00 | 3.11E+00 | 4.51E-01 | |

**Note:**

## RE-1 RISK/HAZARD QUOTIENT FOR RESIDENTIAL RECEPTORS

| CHEMICALS OF CONCERN | CHILD | | | | | | | | AGE-ADJUSTED | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SURFICIAL SOIL | | SUB-SURFACE SOIL | | GROUNDWATER | | SOIL-VAPOR | | SURFICIAL SOIL | | SUB-SURFACE SOIL | | GROUNDWATER | | SOIL-VAPOR | |
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | | Indoor Inhalation of Vapor Emissions | |
| | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ | Risk | HQ |
| Ammonia | NTOX | 9.08E-01 | NTOX | 1.02E+02 | NTOX | 1.93E+00 | | | NTOX | 1.72E-01 | NTOX | 1.91E+01 | NTOX | 6.51E-01 | | |
| DDT | 6.68E-07 | 4.59E-02 | 1.36E-09 | 9.33E-05 | | | | | 9.83E-07 | 1.35E-02 | 2.30E-09 | 3.15E-05 | | | | |
| Dieldrin | 3.33E-07 | 4.86E-03 | 2.06E-08 | 3.01E-04 | | | | | 4.93E-07 | 1.44E-03 | 3.48E-08 | 1.02E-04 | | | | |
| Naphthalene | NTOX | 3.57E-03 | NTOX | 3.54E-01 | | | | | NTOX | 7.04E-04 | NTOX | 1.18E-01 | | | | |
| Nitrate (as Sodium Nitrate) | NTOX | 1.11E-04 | NTOX | NTOX | NPCP | NPCP | | | NTOX | 3.28E-05 | NTOX | NTOX | NPCP | NPCP | | |
| Nitrite (as Sodium Nitrite) | NTOX | 3.44E-04 | NTOX | NTOX | NPCP | NPCP | | | NTOX | 1.01E-04 | NTOX | NTOX | NPCP | NPCP | | |

**Notes:**

**NPCP: A physical-chemical parameter, required in the calculation of the value, is not available.**

**NTOX: The toxicity parameter(s) required in the calculation of the value, is not available.**

**NCOC: The chemical is not a COC for the pathway because it was selected, but no representative concentration was entered.**

# RATL-1 FOR NON-RESIDENTIAL RECEPTORS

| CHEMICALS OF CONCERN | SURFICIAL SOIL | SUB-SURFACE SOIL | GROUNDWATER | SOIL-VAPOR |
|---|---|---|---|---|
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions | Indoor Inhalation of Vapor Emissions |
| | [mg/kg] | [mg/kg] | [mg/L] | [$\mu g/m^3$] |
| Ammonia | 7.16E+01 | 1.69E+01 | 1.67E+02 | NA |
| DDT | 5.07E+01 | 1.71E+03 | NA | NA |
| Dieldrin | 1.55E+00 | 5.15E+01 | NA | NA |
| Naphthalene | 1.87E+01 | 4.61E+00 | NA | NA |
| Nitrate (as Sodium Nitrate) | 2.00E+05 | NA | NA | NA |
| Nitrite (as Sodium Nitrite) | 1.25E+04 | NA | NA | NA |

**Notes:**

**NA: Not applicable because the chemical is not a COC for the pathway (no representative concentration enetered) or its properties (toxicity and/or physical-chemical) are not available.**

# RE-1 REPRESENTATIVE CONCENTRATIONS FOR CONSTRUCTION WORKER

| CHEMICALS OF CONCERN | SOIL TO TYPICAL DEPTH OF CONSTRUCTION |
|---|---|
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion |
| | Representative Concentration [mg/kg] |
| Ammonia | 4.25E+02 |
| DDT | 1.68E+00 |
| Dieldrin | 1.10E-02 |
| Naphthalene | 4.05E-01 |
| Nitrate (as Sodium Nitrate) | 1.61E+01 |
| Nitrite (as Sodium Nitrite) | 3.11E+00 |

**Note:**

# RE-1 RISK/HAZARD QUOTIENT FOR CONSTRUCTION WORKERS

| CHEMICALS OF CONCERN | SURFICIAL SOIL | |
|---|---|---|
| | Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion | |
| | Risk | HQ |
| Ammonia | NTOX | 5.77E-01 |
| DDT | 6.12E-09 | 2.52E-03 |
| Dieldrin | 2.26E-09 | 1.98E-04 |
| Naphthalene | NTOX | 2.11E-03 |
| Nitrate (as Sodium Nitrate) | NTOX | 5.87E-06 |
| Nitrite (as Sodium Nitrite) | NTOX | 1.82E-05 |

**Notes:**
**NPCP: A physical-chemical parameter, required in the calculation of the value, is not available.**

**NTOX: The toxicity parameter(s) required in the calculation of the value, is not available.**
**NCOC: The chemical is not a COC for the pathway because it was selected, but no representative concentration was entered.**

# RATL-1 FOR CONSTRUCTION WORKERS

**RATLs NOT REQUIRED**

| CHEMICALS OF CONCERN | SURFICIAL SOIL<br>Inhalation of Vapors and Particulates, Dermal Contact, and Accidental Ingestion<br>[mg/kg] |
|---|---|
| Ammonia | 1.23E+02 |
| DDT | 1.11E+02 |
| Dieldrin | 9.27E+00 |
| Naphthalene | 3.20E+01 |
| Nitrate (as Sodium Nitrate) | 4.57E+05 |
| Nitrite (as Sodium Nitrite) | 2.85E+04 |

**Notes:**

**NA: Not applicable because the chemical is not a COC for the pathway (no representative concentration enetered) or its properties (toxicity and/or physical-chemical) are not available.**

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **UCL Statistics for Data Sets with Non-Detects** | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | User Selected Options | | | | | | | | | | | |
| 4 | Date/Time of Computation | | | 5/27/2015 12:26:14 PM | | | | | | | | |
| 5 | From File | | | ProUCL_6J_RE.xls | | | | | | | | |
| 6 | Full Precision | | | OFF | | | | | | | | |
| 7 | Confidence Coefficient | | | 95% | | | | | | | | |
| 8 | Number of Bootstrap Operations | | | 2000 | | | | | | | | |
| 9 | **dieldrin soil** | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| 11 | **General Statistics** | | | | | | | | | | | |
| 12 | Total Number of Observations | | | | | 20 | | Number of Distinct Observations | | | | 6 |
| 13 | Number of Detects | | | | | 1 | | Number of Non-Detects | | | | 19 |
| 14 | Number of Distinct Detects | | | | | 1 | | Number of Distinct Non-Detects | | | | 5 |
| 15 | | | | | | | | | | | | |
| 16 | **Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!** | | | | | | | | | | | |
| 17 | **It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).** | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | **The data set for variable dieldrin soil was not processed!** | | | | | | | | | | | |

## UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | 8/3/2015 12:42:12 PM |
| From File | ProUCL_6J_RE_DDTupdate_a.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**DDT soil sur**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 20 | Number of Distinct Observations | 16 |
| Number of Detects | 14 | Number of Non-Detects | 6 |
| Number of Distinct Detects | 14 | Number of Distinct Non-Detects | 2 |
| Minimum Detect | 0.004 | Minimum Non-Detect | 4.1000E-4 |
| Maximum Detect | 4.23 | Maximum Non-Detect | 0.005 |
| Variance Detects | 1.8 | Percent Non-Detects | 30% |
| Mean Detects | 1.006 | SD Detects | 1.342 |
| Median Detects | 0.508 | CV Detects | 1.334 |
| Skewness Detects | 1.58 | Kurtosis Detects | 1.575 |
| Mean of Logged Detects | -1.38 | SD of Logged Detects | 2.246 |

### Normal GOF Test on Detects Only

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.759 | **Shapiro Wilk GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.874 | Detected Data Not Normal at 5% Significance Level |
| Lilliefors Test Statistic | 0.286 | **Lilliefors GOF Test** |
| 5% Lilliefors Critical Value | 0.237 | Detected Data Not Normal at 5% Significance Level |

**Detected Data Not Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

| | | | |
|---|---|---|---|
| Mean | 0.705 | Standard Error of Mean | 0.273 |
| SD | 1.175 | 95% KM (BCA) UCL | 1.186 |
| 95% KM (t) UCL | 1.176 | 95% KM (Percentile Bootstrap) UCL | 1.176 |
| 95% KM (z) UCL | 1.153 | 95% KM Bootstrap t UCL | 1.603 |
| 90% KM Chebyshev UCL | 1.523 | 95% KM Chebyshev UCL | 1.893 |
| 97.5% KM Chebyshev UCL | 2.408 | 99% KM Chebyshev UCL | 3.418 |

### Gamma GOF Tests on Detected Observations Only

| | | |
|---|---|---|
| A-D Test Statistic | 0.248 | **Anderson-Darling GOF Test** |
| 5% A-D Critical Value | 0.8 | Detected data appear Gamma Distributed at 5% Significance Level |
| K-S Test Statistic | 0.113 | **Kolmogrov-Smirnoff GOF** |
| 5% K-S Critical Value | 0.243 | Detected data appear Gamma Distributed at 5% Significance Level |

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

| | | | |
|---|---|---|---|
| k hat (MLE) | 0.464 | k star (bias corrected MLE) | 0.412 |
| Theta hat (MLE) | 2.168 | Theta star (bias corrected MLE) | 2.441 |
| nu hat (MLE) | 12.99 | nu star (bias corrected) | 11.54 |
| MLE Mean (bias corrected) | 1.006 | MLE Sd (bias corrected) | 1.567 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | | | | | | | | | | | | |
| 52 | **Gamma Kaplan-Meier (KM) Statistics** | | | | | | | | | | | |
| 53 | | | | | k hat (KM) | 0.359 | | | | nu hat (KM) | 14.37 | |
| 54 | | | | | Approximate Chi Square Value (14.37, α) | 6.826 | | | | Adjusted Chi Square Value (14.37, β) | 6.417 | |
| 55 | | | | | 95% Gamma Approximate KM-UCL (use when n>=50) | 1.483 | | | | 95% Gamma Adjusted KM-UCL (use when n<50) | 1.578 | |
| 56 | | | | | | | | | | | | |
| 57 | **Gamma ROS Statistics using Imputed Non-Detects** | | | | | | | | | | | |
| 58 | GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs | | | | | | | | | | | |
| 59 | GROS may not be used when kstar of detected data is small such as < 0.1 | | | | | | | | | | | |
| 60 | For such situations, GROS method tends to yield inflated values of UCLs and BTVs | | | | | | | | | | | |
| 61 | For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates | | | | | | | | | | | |
| 62 | | | | | Minimum | 0.004 | | | | Mean | 0.707 | |
| 63 | | | | | Maximum | 4.23 | | | | Median | 0.111 | |
| 64 | | | | | SD | 1.204 | | | | CV | 1.704 | |
| 65 | | | | | k hat (MLE) | 0.338 | | | | k star (bias corrected MLE) | 0.321 | |
| 66 | | | | | Theta hat (MLE) | 2.092 | | | | Theta star (bias corrected MLE) | 2.205 | |
| 67 | | | | | nu hat (MLE) | 13.52 | | | | nu star (bias corrected) | 12.83 | |
| 68 | | | | | MLE Mean (bias corrected) | 0.707 | | | | MLE Sd (bias corrected) | 1.248 | |
| 69 | | | | | | | | | | Adjusted Level of Significance (β) | 0.038 | |
| 70 | | | | | Approximate Chi Square Value (12.83, α) | 5.775 | | | | Adjusted Chi Square Value (12.83, β) | 5.404 | |
| 71 | | | | | 95% Gamma Approximate UCL (use when n>=50) | 1.57 | | | | 95% Gamma Adjusted UCL (use when n<50) | 1.678 | |
| 72 | | | | | | | | | | | | |
| 73 | **Lognormal GOF Test on Detected Observations Only** | | | | | | | | | | | |
| 74 | | | | | Shapiro Wilk Test Statistic | 0.918 | | | | **Shapiro Wilk GOF Test** | | |
| 75 | | | | | 5% Shapiro Wilk Critical Value | 0.874 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 76 | | | | | Lilliefors Test Statistic | 0.194 | | | | **Lilliefors GOF Test** | | |
| 77 | | | | | 5% Lilliefors Critical Value | 0.237 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 78 | **Detected Data appear Lognormal at 5% Significance Level** | | | | | | | | | | | |
| 79 | | | | | | | | | | | | |
| 80 | **Lognormal ROS Statistics Using Imputed Non-Detects** | | | | | | | | | | | |
| 81 | | | | | Mean in Original Scale | 0.705 | | | | Mean in Log Scale | -2.861 | |
| 82 | | | | | SD in Original Scale | 1.206 | | | | SD in Log Scale | 3.043 | |
| 83 | | | | | 95% t UCL (assumes normality of ROS data) | 1.171 | | | | 95% Percentile Bootstrap UCL | 1.149 | |
| 84 | | | | | 95% BCA Bootstrap UCL | 1.273 | | | | 95% Bootstrap t UCL | 1.51 | |
| 85 | | | | | 95% H-UCL (Log ROS) | 459.5 | | | | | | |
| 86 | | | | | | | | | | | | |
| 87 | **UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed** | | | | | | | | | | | |
| 88 | | | | | KM Mean (logged) | -3.021 | | | | 95% H-UCL (KM -Log) | 747.2 | |
| 89 | | | | | KM SD (logged) | 3.153 | | | | 95% Critical H Value (KM-Log) | 6.453 | |
| 90 | | | | | KM Standard Error of Mean (logged) | 0.772 | | | | | | |
| 91 | | | | | | | | | | | | |
| 92 | **DL/2 Statistics** | | | | | | | | | | | |
| 93 | **DL/2 Normal** | | | | | | | | | **DL/2 Log-Transformed** | | |
| 94 | | | | | Mean in Original Scale | 0.705 | | | | Mean in Log Scale | -2.889 | |
| 95 | | | | | SD in Original Scale | 1.206 | | | | SD in Log Scale | 3.052 | |
| 96 | | | | | 95% t UCL (Assumes normality) | 1.171 | | | | 95% H-Stat UCL | 469.7 | |
| 97 | **DL/2 is not a recommended method, provided for comparisons and historical reasons** | | | | | | | | | | | |
| 98 | | | | | | | | | | | | |
| 99 | **Nonparametric Distribution Free UCL Statistics** | | | | | | | | | | | |
| 100 | **Detected Data appear Gamma Distributed at 5% Significance Level** | | | | | | | | | | | |

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | | | | | | | | | | | | |
| 102 | **Suggested UCL to Use** | | | | | | | | | | | |
| 103 | 95% KM (BCA) UCL | | | | | 1.186 | 95% GROS Adjusted Gamma UCL | | | | | 1.678 |
| 104 | 95% Adjusted Gamma KM-UCL | | | | | 1.578 | | | | | | |
| 105 | | | | | | | | | | | | |
| 106 | Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. | | | | | | | | | | | |
| 107 | Recommendations are based upon data size, data distribution, and skewness. | | | | | | | | | | | |
| 108 | These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). | | | | | | | | | | | |
| 109 | However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician. | | | | | | | | | | | |
| 110 | | | | | | | | | | | | |

## UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | 8/3/2015 12:45:24 PM |
| From File | ProUCL_6J_RE_DDTupdate_a.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**DDT soil sub**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 20 | Number of Distinct Observations | 11 |
| Number of Detects | 5 | Number of Non-Detects | 15 |
| Number of Distinct Detects | 5 | Number of Distinct Non-Detects | 6 |
| Minimum Detect | 0.0116 | Minimum Non-Detect | 3.6000E-4 |
| Maximum Detect | 0.228 | Maximum Non-Detect | 0.005 |
| Variance Detects | 0.00761 | Percent Non-Detects | 75% |
| Mean Detects | 0.0766 | SD Detects | 0.0873 |
| Median Detects | 0.0452 | CV Detects | 1.138 |
| Skewness Detects | 1.915 | Kurtosis Detects | 3.839 |
| Mean of Logged Detects | -3.048 | SD of Logged Detects | 1.1 |

### Normal GOF Test on Detects Only

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.774 | **Shapiro Wilk GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.762 | Detected Data appear Normal at 5% Significance Level |
| Lilliefors Test Statistic | 0.333 | **Lilliefors GOF Test** |
| 5% Lilliefors Critical Value | 0.396 | Detected Data appear Normal at 5% Significance Level |

**Detected Data appear Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

| | | | |
|---|---|---|---|
| Mean | 0.0194 | Standard Error of Mean | 0.0128 |
| SD | 0.0511 | 95% KM (BCA) UCL | 0.0422 |
| 95% KM (t) UCL | 0.0415 | 95% KM (Percentile Bootstrap) UCL | 0.0407 |
| 95% KM (z) UCL | 0.0405 | 95% KM Bootstrap t UCL | 0.0598 |
| 90% KM Chebyshev UCL | 0.0578 | 95% KM Chebyshev UCL | 0.0751 |
| 97.5% KM Chebyshev UCL | 0.0992 | 99% KM Chebyshev UCL | 0.147 |

### Gamma GOF Tests on Detected Observations Only

| | | |
|---|---|---|
| A-D Test Statistic | 0.28 | **Anderson-Darling GOF Test** |
| 5% A-D Critical Value | 0.69 | Detected data appear Gamma Distributed at 5% Significance Level |
| K-S Test Statistic | 0.218 | **Kolmogrov-Smirnoff GOF** |
| 5% K-S Critical Value | 0.363 | Detected data appear Gamma Distributed at 5% Significance Level |

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

| | | | |
|---|---|---|---|
| k hat (MLE) | 1.182 | k star (bias corrected MLE) | 0.606 |
| Theta hat (MLE) | 0.0649 | Theta star (bias corrected MLE) | 0.126 |
| nu hat (MLE) | 11.82 | nu star (bias corrected) | 6.061 |
| MLE Mean (bias corrected) | 0.0766 | MLE Sd (bias corrected) | 0.0984 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | | | | | | | | | | | | |
| 52 | **Gamma Kaplan-Meier (KM) Statistics** | | | | | | | | | | | |
| 53 | | | | | k hat (KM) | 0.144 | | | | nu hat (KM) | 5.778 | |
| 54 | | | | | Approximate Chi Square Value (5.78, α) | 1.528 | | | | Adjusted Chi Square Value (5.78, β) | 1.363 | |
| 55 | | | | | 95% Gamma Approximate KM-UCL (use when n>=50) | 0.0735 | | | | 95% Gamma Adjusted KM-UCL (use when n<50) | 0.0824 | |
| 56 | | | | | | | | | | | | |
| 57 | **Gamma ROS Statistics using Imputed Non-Detects** | | | | | | | | | | | |
| 58 | GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs | | | | | | | | | | | |
| 59 | GROS may not be used when kstar of detected data is small such as < 0.1 | | | | | | | | | | | |
| 60 | For such situations, GROS method tends to yield inflated values of UCLs and BTVs | | | | | | | | | | | |
| 61 | For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates | | | | | | | | | | | |
| 62 | | | | | Minimum | 0.01 | | | | Mean | 0.0267 | |
| 63 | | | | | Maximum | 0.228 | | | | Median | 0.01 | |
| 64 | | | | | SD | 0.0498 | | | | CV | 1.868 | |
| 65 | | | | | k hat (MLE) | 0.979 | | | | k star (bias corrected MLE) | 0.865 | |
| 66 | | | | | Theta hat (MLE) | 0.0272 | | | | Theta star (bias corrected MLE) | 0.0308 | |
| 67 | | | | | nu hat (MLE) | 39.15 | | | | nu star (bias corrected) | 34.61 | |
| 68 | | | | | MLE Mean (bias corrected) | 0.0267 | | | | MLE Sd (bias corrected) | 0.0287 | |
| 69 | | | | | | | | | | Adjusted Level of Significance (β) | 0.038 | |
| 70 | | | | | Approximate Chi Square Value (34.61, α) | 22.15 | | | | Adjusted Chi Square Value (34.61, β) | 21.36 | |
| 71 | | | | | 95% Gamma Approximate UCL (use when n>=50) | 0.0417 | | | | 95% Gamma Adjusted UCL (use when n<50) | 0.0432 | |
| 72 | | | | | | | | | | | | |
| 73 | **Lognormal GOF Test on Detected Observations Only** | | | | | | | | | | | |
| 74 | | | | | Shapiro Wilk Test Statistic | 0.991 | | | | **Shapiro Wilk GOF Test** | | |
| 75 | | | | | 5% Shapiro Wilk Critical Value | 0.762 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 76 | | | | | Lilliefors Test Statistic | 0.165 | | | | **Lilliefors GOF Test** | | |
| 77 | | | | | 5% Lilliefors Critical Value | 0.396 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 78 | **Detected Data appear Lognormal at 5% Significance Level** | | | | | | | | | | | |
| 79 | | | | | | | | | | | | |
| 80 | **Lognormal ROS Statistics Using Imputed Non-Detects** | | | | | | | | | | | |
| 81 | | | | | Mean in Original Scale | 0.0199 | | | | Mean in Log Scale | -6.573 | |
| 82 | | | | | SD in Original Scale | 0.0523 | | | | SD in Log Scale | 2.487 | |
| 83 | | | | | 95% t UCL (assumes normality of ROS data) | 0.0401 | | | | 95% Percentile Bootstrap UCL | 0.04 | |
| 84 | | | | | 95% BCA Bootstrap UCL | 0.0541 | | | | 95% Bootstrap t UCL | 0.0905 | |
| 85 | | | | | 95% H-UCL (Log ROS) | 0.597 | | | | | | |
| 86 | | | | | | | | | | | | |
| 87 | **UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed** | | | | | | | | | | | |
| 88 | | | | | KM Mean (logged) | -6.709 | | | | 95% H-UCL (KM -Log) | 0.128 | |
| 89 | | | | | KM SD (logged) | 2.17 | | | | 95% Critical H Value (KM-Log) | 4.615 | |
| 90 | | | | | KM Standard Error of Mean (logged) | 0.543 | | | | | | |
| 91 | | | | | | | | | | | | |
| 92 | **DL/2 Statistics** | | | | | | | | | | | |
| 93 | **DL/2 Normal** | | | | | | | | | **DL/2 Log-Transformed** | | |
| 94 | | | | | Mean in Original Scale | 0.0203 | | | | Mean in Log Scale | -6.018 | |
| 95 | | | | | SD in Original Scale | 0.0521 | | | | SD in Log Scale | 2.138 | |
| 96 | | | | | 95% t UCL (Assumes normality) | 0.0405 | | | | 95% H-Stat UCL | 0.224 | |
| 97 | **DL/2 is not a recommended method, provided for comparisons and historical reasons** | | | | | | | | | | | |
| 98 | | | | | | | | | | | | |
| 99 | **Nonparametric Distribution Free UCL Statistics** | | | | | | | | | | | |
| 100 | **Detected Data appear Normal Distributed at 5% Significance Level** | | | | | | | | | | | |

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | | | | | | | | | | | | |
| 102 | **Suggested UCL to Use** | | | | | | | | | | | |
| 103 | 95% KM (t) UCL | | | | | 0.0415 | 95% KM (Percentile Bootstrap) UCL | | | | | 0.0407 |
| 104 | | | | | | | | | | | | |
| 105 | Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. | | | | | | | | | | | |
| 106 | Recommendations are based upon data size, data distribution, and skewness. | | | | | | | | | | | |
| 107 | These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). | | | | | | | | | | | |
| 108 | However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician. | | | | | | | | | | | |
| 109 | | | | | | | | | | | | |

## UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | 5/27/2015 12:26:14 PM |
| From File | ProUCL_6J_RE.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**ammonia soil**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 22 | Number of Distinct Observations | 19 |
| Number of Detects | 18 | Number of Non-Detects | 4 |
| Number of Distinct Detects | 18 | Number of Distinct Non-Detects | 1 |
| Minimum Detect | 11.3 | Minimum Non-Detect | 4.5 |
| Maximum Detect | 864 | Maximum Non-Detect | 4.5 |
| Variance Detects | 77615 | Percent Non-Detects | 18.18% |
| Mean Detects | 216.3 | SD Detects | 278.6 |
| Median Detects | 83.55 | CV Detects | 1.288 |
| Skewness Detects | 1.506 | Kurtosis Detects | 1.093 |
| Mean of Logged Detects | 4.49 | SD of Logged Detects | 1.453 |

### Normal GOF Test on Detects Only

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.743 | **Shapiro Wilk GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.897 | Detected Data Not Normal at 5% Significance Level |
| Lilliefors Test Statistic | 0.262 | **Lilliefors GOF Test** |
| 5% Lilliefors Critical Value | 0.209 | Detected Data Not Normal at 5% Significance Level |

**Detected Data Not Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

| | | | |
|---|---|---|---|
| Mean | 177.8 | Standard Error of Mean | 56.64 |
| SD | 258.2 | 95% KM (BCA) UCL | 270.4 |
| 95% KM (t) UCL | 275.2 | 95% KM (Percentile Bootstrap) UCL | 273.3 |
| 95% KM (z) UCL | 270.9 | 95% KM Bootstrap t UCL | 316.8 |
| 90% KM Chebyshev UCL | 347.7 | 95% KM Chebyshev UCL | 424.6 |
| 97.5% KM Chebyshev UCL | 531.5 | 99% KM Chebyshev UCL | 741.3 |

### Gamma GOF Tests on Detected Observations Only

| | | |
|---|---|---|
| A-D Test Statistic | 0.577 | **Anderson-Darling GOF Test** |
| 5% A-D Critical Value | 0.784 | Detected data appear Gamma Distributed at 5% Significance Level |
| K-S Test Statistic | 0.155 | **Kolmogrov-Smirnoff GOF** |
| 5% K-S Critical Value | 0.212 | Detected data appear Gamma Distributed at 5% Significance Level |

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

| | | | |
|---|---|---|---|
| k hat (MLE) | 0.684 | k star (bias corrected MLE) | 0.607 |
| Theta hat (MLE) | 316.3 | Theta star (bias corrected MLE) | 356.4 |
| nu hat (MLE) | 24.61 | nu star (bias corrected) | 21.84 |
| MLE Mean (bias corrected) | 216.3 | MLE Sd (bias corrected) | 277.7 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | **Gamma Kaplan-Meier (KM) Statistics** | | | | | | | | | | | |
| 52 | | | | | k hat (KM) | 0.474 | | | | nu hat (KM) | | 20.87 |
| 53 | | | | | Approximate Chi Square Value (20.87, α) | 11.49 | | | | Adjusted Chi Square Value (20.87, β) | | 10.97 |
| 54 | | | | | 95% Gamma Approximate KM-UCL (use when n>=50) | 322.8 | | | | 95% Gamma Adjusted KM-UCL (use when n<50) | | 338 |
| 55 | | | | | | | | | | | | |
| 56 | **Gamma ROS Statistics using Imputed Non-Detects** | | | | | | | | | | | |
| 57 | GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs | | | | | | | | | | | |
| 58 | GROS may not be used when kstar of detected data is small such as < 0.1 | | | | | | | | | | | |
| 59 | For such situations, GROS method tends to yield inflated values of UCLs and BTVs | | | | | | | | | | | |
| 60 | For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates | | | | | | | | | | | |
| 61 | | | | | Minimum | 0.01 | | | | Mean | | 177 |
| 62 | | | | | Maximum | 864 | | | | Median | | 48.4 |
| 63 | | | | | SD | 264.8 | | | | CV | | 1.496 |
| 64 | | | | | k hat (MLE) | 0.295 | | | | k star (bias corrected MLE) | | 0.285 |
| 65 | | | | | Theta hat (MLE) | 599 | | | | Theta star (bias corrected MLE) | | 619.9 |
| 66 | | | | | nu hat (MLE) | 13 | | | | nu star (bias corrected) | | 12.56 |
| 67 | | | | | MLE Mean (bias corrected) | 177 | | | | MLE Sd (bias corrected) | | 331.2 |
| 68 | | | | | | | | | | Adjusted Level of Significance (β) | | 0.0386 |
| 69 | | | | | Approximate Chi Square Value (12.56, α) | 5.598 | | | | Adjusted Chi Square Value (12.56, β) | | 5.254 |
| 70 | | | | | 95% Gamma Approximate UCL (use when n>=50) | 397 | | | | 95% Gamma Adjusted UCL (use when n<50) | | 423.1 |
| 71 | | | | | | | | | | | | |
| 72 | **Lognormal GOF Test on Detected Observations Only** | | | | | | | | | | | |
| 73 | | | | | Shapiro Wilk Test Statistic | 0.943 | | | | **Shapiro Wilk GOF Test** | | |
| 74 | | | | | 5% Shapiro Wilk Critical Value | 0.897 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 75 | | | | | Lilliefors Test Statistic | 0.104 | | | | **Lilliefors GOF Test** | | |
| 76 | | | | | 5% Lilliefors Critical Value | 0.209 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 77 | **Detected Data appear Lognormal at 5% Significance Level** | | | | | | | | | | | |
| 78 | | | | | | | | | | | | |
| 79 | **Lognormal ROS Statistics Using Imputed Non-Detects** | | | | | | | | | | | |
| 80 | | | | | Mean in Original Scale | 177.6 | | | | Mean in Log Scale | | 3.865 |
| 81 | | | | | SD in Original Scale | 264.4 | | | | SD in Log Scale | | 1.9 |
| 82 | | | | | 95% t UCL (assumes normality of ROS data) | 274.6 | | | | 95% Percentile Bootstrap UCL | | 278.9 |
| 83 | | | | | 95% BCA Bootstrap UCL | 301.7 | | | | 95% Bootstrap t UCL | | 327.6 |
| 84 | | | | | 95% H-UCL (Log ROS) | 1530 | | | | | | |
| 85 | | | | | | | | | | | | |
| 86 | **UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed** | | | | | | | | | | | |
| 87 | | | | | KM Mean (logged) | 3.947 | | | | 95% H-UCL (KM -Log) | | 912.7 |
| 88 | | | | | KM SD (logged) | 1.72 | | | | 95% Critical H Value (KM-Log) | | 3.706 |
| 89 | | | | | KM Standard Error of Mean (logged) | 0.377 | | | | | | |
| 90 | | | | | | | | | | | | |
| 91 | **DL/2 Statistics** | | | | | | | | | | | |
| 92 | **DL/2 Normal** | | | | | | | | | **DL/2 Log-Transformed** | | |
| 93 | | | | | Mean in Original Scale | 177.4 | | | | Mean in Log Scale | | 3.821 |
| 94 | | | | | SD in Original Scale | 264.5 | | | | SD in Log Scale | | 1.954 |
| 95 | | | | | 95% t UCL (Assumes normality) | 274.4 | | | | 95% H-Stat UCL | | 1773 |
| 96 | **DL/2 is not a recommended method, provided for comparisons and historical reasons** | | | | | | | | | | | |
| 97 | | | | | | | | | | | | |
| 98 | **Nonparametric Distribution Free UCL Statistics** | | | | | | | | | | | |
| 99 | **Detected Data appear Gamma Distributed at 5% Significance Level** | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | **Suggested UCL to Use** | | | | | | | | | | | |
| 102 | | | | | 95% KM (Chebyshev) UCL | 424.6 | | | | 95% GROS Adjusted Gamma UCL | | 423.1 |
| 103 | | | | | 95% Adjusted Gamma KM-UCL | 338 | | | | | | |
| 104 | | | | | | | | | | | | |
| 105 | Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. | | | | | | | | | | | |
| 106 | Recommendations are based upon data size, data distribution, and skewness. | | | | | | | | | | | |
| 107 | These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). | | | | | | | | | | | |
| 108 | However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician. | | | | | | | | | | | |

## UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | 5/27/2015 12:26:14 PM |
| From File | ProUCL_6J_RE.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**ammonia gw**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 11 | Number of Distinct Observations | 11 |
| Number of Detects | 9 | Number of Non-Detects | 2 |
| Number of Distinct Detects | 9 | Number of Distinct Non-Detects | 2 |
| Minimum Detect | 12.2 | Minimum Non-Detect | 0.05 |
| Maximum Detect | 163 | Maximum Non-Detect | 0.2 |
| Variance Detects | 3790 | Percent Non-Detects | 18.18% |
| Mean Detects | 58.66 | SD Detects | 61.56 |
| Median Detects | 26.6 | CV Detects | 1.05 |
| Skewness Detects | 1.228 | Kurtosis Detects | -0.0707 |
| Mean of Logged Detects | 3.574 | SD of Logged Detects | 1.056 |

### Normal GOF Test on Detects Only

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.748 | **Shapiro Wilk GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.829 | Detected Data Not Normal at 5% Significance Level |
| Lilliefors Test Statistic | 0.254 | **Lilliefors GOF Test** |
| 5% Lilliefors Critical Value | 0.295 | Detected Data appear Normal at 5% Significance Level |

**Detected Data appear Approximate Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

| | | | |
|---|---|---|---|
| Mean | 48 | Standard Error of Mean | 18.28 |
| SD | 57.16 | 95% KM (BCA) UCL | 79.85 |
| 95% KM (t) UCL | 81.13 | 95% KM (Percentile Bootstrap) UCL | 77.29 |
| 95% KM (z) UCL | 78.07 | 95% KM Bootstrap t UCL | 120.4 |
| 90% KM Chebyshev UCL | 102.8 | 95% KM Chebyshev UCL | 127.7 |
| 97.5% KM Chebyshev UCL | 162.2 | 99% KM Chebyshev UCL | 229.9 |

### Gamma GOF Tests on Detected Observations Only

| | | |
|---|---|---|
| A-D Test Statistic | 0.694 | **Anderson-Darling GOF Test** |
| 5% A-D Critical Value | 0.741 | Detected data appear Gamma Distributed at 5% Significance Level |
| K-S Test Statistic | 0.245 | **Kolmogrov-Smirnoff GOF** |
| 5% K-S Critical Value | 0.286 | Detected data appear Gamma Distributed at 5% Significance Level |

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

| | | | |
|---|---|---|---|
| k hat (MLE) | 1.142 | k star (bias corrected MLE) | 0.835 |
| Theta hat (MLE) | 51.38 | Theta star (bias corrected MLE) | 70.23 |
| nu hat (MLE) | 20.55 | nu star (bias corrected) | 15.03 |
| MLE Mean (bias corrected) | 58.66 | MLE Sd (bias corrected) | 64.18 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | **Gamma Kaplan-Meier (KM) Statistics** | | | | | | | | | | | |
| 52 | | | | | k hat (KM) | 0.705 | | | | nu hat (KM) | | 15.51 |
| 53 | | | | | Approximate Chi Square Value (15.51, α) | 7.62 | | | | Adjusted Chi Square Value (15.51, β) | | 6.737 |
| 54 | | | | | 95% Gamma Approximate KM-UCL (use when n>=50) | 97.72 | | | | 95% Gamma Adjusted KM-UCL (use when n<50) | | 110.5 |
| 55 | | | | | | | | | | | | |
| 56 | **Gamma ROS Statistics using Imputed Non-Detects** | | | | | | | | | | | |
| 57 | GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs | | | | | | | | | | | |
| 58 | GROS may not be used when kstar of detected data is small such as < 0.1 | | | | | | | | | | | |
| 59 | For such situations, GROS method tends to yield inflated values of UCLs and BTVs | | | | | | | | | | | |
| 60 | For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates | | | | | | | | | | | |
| 61 | | | | | Minimum | 0.01 | | | | Mean | | 47.99 |
| 62 | | | | | Maximum | 163 | | | | Median | | 15.2 |
| 63 | | | | | SD | 59.96 | | | | CV | | 1.249 |
| 64 | | | | | k hat (MLE) | 0.373 | | | | k star (bias corrected MLE) | | 0.332 |
| 65 | | | | | Theta hat (MLE) | 128.7 | | | | Theta star (bias corrected MLE) | | 144.6 |
| 66 | | | | | nu hat (MLE) | 8.205 | | | | nu star (bias corrected) | | 7.301 |
| 67 | | | | | MLE Mean (bias corrected) | 47.99 | | | | MLE Sd (bias corrected) | | 83.31 |
| 68 | | | | | | | | | | Adjusted Level of Significance (β) | | 0.0278 |
| 69 | | | | | Approximate Chi Square Value (7.30, α) | 2.337 | | | | Adjusted Chi Square Value (7.30, β) | | 1.906 |
| 70 | | | | | 95% Gamma Approximate UCL (use when n>=50) | 149.9 | | | | 95% Gamma Adjusted UCL (use when n<50) | | 183.8 |
| 71 | | | | | | | | | | | | |
| 72 | **Lognormal GOF Test on Detected Observations Only** | | | | | | | | | | | |
| 73 | | | | | Shapiro Wilk Test Statistic | 0.853 | | | | **Shapiro Wilk GOF Test** | | |
| 74 | | | | | 5% Shapiro Wilk Critical Value | 0.829 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 75 | | | | | Lilliefors Test Statistic | 0.235 | | | | **Lilliefors GOF Test** | | |
| 76 | | | | | 5% Lilliefors Critical Value | 0.295 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 77 | **Detected Data appear Lognormal at 5% Significance Level** | | | | | | | | | | | |
| 78 | | | | | | | | | | | | |
| 79 | **Lognormal ROS Statistics Using Imputed Non-Detects** | | | | | | | | | | | |
| 80 | | | | | Mean in Original Scale | 48.53 | | | | Mean in Log Scale | | 3.122 |
| 81 | | | | | SD in Original Scale | 59.49 | | | | SD in Log Scale | | 1.38 |
| 82 | | | | | 95% t UCL (assumes normality of ROS data) | 81.04 | | | | 95% Percentile Bootstrap UCL | | 80.39 |
| 83 | | | | | 95% BCA Bootstrap UCL | 84.76 | | | | 95% Bootstrap t UCL | | 125.2 |
| 84 | | | | | 95% H-UCL (Log ROS) | 304.6 | | | | | | |
| 85 | | | | | | | | | | | | |
| 86 | **UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed** | | | | | | | | | | | |
| 87 | | | | | KM Mean (logged) | 2.379 | | | | 95% H-UCL (KM -Log) | | 125326 |
| 88 | | | | | KM SD (logged) | 2.689 | | | | 95% Critical H Value (KM-Log) | | 6.755 |
| 89 | | | | | KM Standard Error of Mean (logged) | 0.86 | | | | | | |
| 90 | | | | | | | | | | | | |
| 91 | **DL/2 Statistics** | | | | | | | | | | | |
| 92 | **DL/2 Normal** | | | | | | | | | **DL/2 Log-Transformed** | | |
| 93 | | | | | Mean in Original Scale | 48 | | | | Mean in Log Scale | | 2.379 |
| 94 | | | | | SD in Original Scale | 59.95 | | | | SD in Log Scale | | 2.837 |
| 95 | | | | | 95% t UCL (Assumes normality) | 80.76 | | | | 95% H-Stat UCL | | 354380 |
| 96 | **DL/2 is not a recommended method, provided for comparisons and historical reasons** | | | | | | | | | | | |
| 97 | | | | | | | | | | | | |
| 98 | **Nonparametric Distribution Free UCL Statistics** | | | | | | | | | | | |
| 99 | **Detected Data appear Approximate Normal Distributed at 5% Significance Level** | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | **Suggested UCL to Use** | | | | | | | | | | | |
| 102 | | | | | 95% KM (t) UCL | 81.13 | | | | 95% KM (Percentile Bootstrap) UCL | | 77.29 |
| 103 | | | | | | | | | | | | |
| 104 | Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. | | | | | | | | | | | |
| 105 | Recommendations are based upon data size, data distribution, and skewness. | | | | | | | | | | | |
| 106 | These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). | | | | | | | | | | | |
| 107 | However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician. | | | | | | | | | | | |

## UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | 5/27/2015 12:26:14 PM |
| From File | ProUCL_6J_RE.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**nitrate soil**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 22 | Number of Distinct Observations | 22 |
| Number of Detects | 9 | Number of Non-Detects | 13 |
| Number of Distinct Detects | 9 | Number of Distinct Non-Detects | 13 |
| Minimum Detect | 2.91 | Minimum Non-Detect | 2.92 |
| Maximum Detect | 48.5 | Maximum Non-Detect | 27.8 |
| Variance Detects | 253.2 | Percent Non-Detects | 59.09% |
| Mean Detects | 16.47 | SD Detects | 15.91 |
| Median Detects | 9.41 | CV Detects | 0.966 |
| Skewness Detects | 1.333 | Kurtosis Detects | 0.707 |
| Mean of Logged Detects | 2.394 | SD of Logged Detects | 0.964 |

### Normal GOF Test on Detects Only

| | | |
|---|---|---|
| Shapiro Wilk Test Statistic | 0.809 | **Shapiro Wilk GOF Test** |
| 5% Shapiro Wilk Critical Value | 0.829 | Detected Data Not Normal at 5% Significance Level |
| Lilliefors Test Statistic | 0.32 | **Lilliefors GOF Test** |
| 5% Lilliefors Critical Value | 0.295 | Detected Data Not Normal at 5% Significance Level |

**Detected Data Not Normal at 5% Significance Level**

### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

| | | | |
|---|---|---|---|
| Mean | 9.287 | Standard Error of Mean | 2.655 |
| SD | 11.5 | 95% KM (BCA) UCL | 13.74 |
| 95% KM (t) UCL | 13.86 | 95% KM (Percentile Bootstrap) UCL | 13.61 |
| 95% KM (z) UCL | 13.65 | 95% KM Bootstrap t UCL | 17.47 |
| 90% KM Chebyshev UCL | 17.25 | 95% KM Chebyshev UCL | 20.86 |
| 97.5% KM Chebyshev UCL | 25.87 | 99% KM Chebyshev UCL | 35.71 |

### Gamma GOF Tests on Detected Observations Only

| | | |
|---|---|---|
| A-D Test Statistic | 0.429 | **Anderson-Darling GOF Test** |
| 5% A-D Critical Value | 0.737 | Detected data appear Gamma Distributed at 5% Significance Level |
| K-S Test Statistic | 0.255 | **Kolmogrov-Smirnoff GOF** |
| 5% K-S Critical Value | 0.285 | Detected data appear Gamma Distributed at 5% Significance Level |

**Detected data appear Gamma Distributed at 5% Significance Level**

### Gamma Statistics on Detected Data Only

| | | | |
|---|---|---|---|
| k hat (MLE) | 1.371 | k star (bias corrected MLE) | 0.988 |
| Theta hat (MLE) | 12.01 | Theta star (bias corrected MLE) | 16.66 |
| nu hat (MLE) | 24.68 | nu star (bias corrected) | 17.79 |
| MLE Mean (bias corrected) | 16.47 | MLE Sd (bias corrected) | 16.56 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | **Gamma Kaplan-Meier (KM) Statistics** | | | | | | | | | | | |
| 52 | | | | | k hat (KM) | 0.653 | | | | nu hat (KM) | | 28.71 |
| 53 | | | | | Approximate Chi Square Value (28.71, α) | 17.49 | | | | Adjusted Chi Square Value (28.71, β) | | 16.83 |
| 54 | | | | | 95% Gamma Approximate KM-UCL (use when n>=50) | 15.25 | | | | 95% Gamma Adjusted KM-UCL (use when n<50) | | 15.84 |
| 55 | | | | | | | | | | | | |
| 56 | **Gamma ROS Statistics using Imputed Non-Detects** | | | | | | | | | | | |
| 57 | GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs | | | | | | | | | | | |
| 58 | GROS may not be used when kstar of detected data is small such as < 0.1 | | | | | | | | | | | |
| 59 | For such situations, GROS method tends to yield inflated values of UCLs and BTVs | | | | | | | | | | | |
| 60 | For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates | | | | | | | | | | | |
| 61 | | | | | Minimum | 0.01 | | | | Mean | | 7.083 |
| 62 | | | | | Maximum | 48.5 | | | | Median | | 0.858 |
| 63 | | | | | SD | 12.67 | | | | CV | | 1.789 |
| 64 | | | | | k hat (MLE) | 0.331 | | | | k star (bias corrected MLE) | | 0.316 |
| 65 | | | | | Theta hat (MLE) | 21.43 | | | | Theta star (bias corrected MLE) | | 22.43 |
| 66 | | | | | nu hat (MLE) | 14.55 | | | | nu star (bias corrected) | | 13.9 |
| 67 | | | | | MLE Mean (bias corrected) | 7.083 | | | | MLE Sd (bias corrected) | | 12.6 |
| 68 | | | | | | | | | | Adjusted Level of Significance (β) | | 0.0386 |
| 69 | | | | | Approximate Chi Square Value (13.90, α) | 6.5 | | | | Adjusted Chi Square Value (13.90, β) | | 6.125 |
| 70 | | | | | 95% Gamma Approximate UCL (use when n>=50) | 15.14 | | | | 95% Gamma Adjusted UCL (use when n<50) | | 16.07 |
| 71 | | | | | | | | | | | | |
| 72 | **Lognormal GOF Test on Detected Observations Only** | | | | | | | | | | | |
| 73 | | | | | Shapiro Wilk Test Statistic | 0.942 | | | | **Shapiro Wilk GOF Test** | | |
| 74 | | | | | 5% Shapiro Wilk Critical Value | 0.829 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 75 | | | | | Lilliefors Test Statistic | 0.196 | | | | **Lilliefors GOF Test** | | |
| 76 | | | | | 5% Lilliefors Critical Value | 0.295 | | | | Detected Data appear Lognormal at 5% Significance Level | | |
| 77 | **Detected Data appear Lognormal at 5% Significance Level** | | | | | | | | | | | |
| 78 | | | | | | | | | | | | |
| 79 | **Lognormal ROS Statistics Using Imputed Non-Detects** | | | | | | | | | | | |
| 80 | | | | | Mean in Original Scale | 8.681 | | | | Mean in Log Scale | | 1.655 |
| 81 | | | | | SD in Original Scale | 11.87 | | | | SD in Log Scale | | 0.902 |
| 82 | | | | | 95% t UCL (assumes normality of ROS data) | 13.04 | | | | 95% Percentile Bootstrap UCL | | 13.03 |
| 83 | | | | | 95% BCA Bootstrap UCL | 15.02 | | | | 95% Bootstrap t UCL | | 18.47 |
| 84 | | | | | 95% H-UCL (Log ROS) | 12.73 | | | | | | |
| 85 | | | | | | | | | | | | |
| 86 | **UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed** | | | | | | | | | | | |
| 87 | | | | | KM Mean (logged) | 1.765 | | | | 95% H-UCL (KM -Log) | | 13.27 |
| 88 | | | | | KM SD (logged) | 0.86 | | | | 95% Critical H Value (KM-Log) | | 2.397 |
| 89 | | | | | KM Standard Error of Mean (logged) | 0.216 | | | | | | |
| 90 | | | | | | | | | | | | |
| 91 | **DL/2 Statistics** | | | | | | | | | | | |
| 92 | **DL/2 Normal** | | | | | | | | | **DL/2 Log-Transformed** | | |
| 93 | | | | | Mean in Original Scale | 10.03 | | | | Mean in Log Scale | | 1.829 |
| 94 | | | | | SD in Original Scale | 11.61 | | | | SD in Log Scale | | 0.994 |
| 95 | | | | | 95% t UCL (Assumes normality) | 14.29 | | | | 95% H-Stat UCL | | 17.84 |
| 96 | **DL/2 is not a recommended method, provided for comparisons and historical reasons** | | | | | | | | | | | |
| 97 | | | | | | | | | | | | |
| 98 | **Nonparametric Distribution Free UCL Statistics** | | | | | | | | | | | |
| 99 | **Detected Data appear Gamma Distributed at 5% Significance Level** | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | **Suggested UCL to Use** | | | | | | | | | | | |
| 102 | | | | | 95% KM (t) UCL | 13.86 | | | | 95% GROS Adjusted Gamma UCL | | 16.07 |
| 103 | | | | | 95% Adjusted Gamma KM-UCL | 15.84 | | | | | | |
| 104 | | | | | | | | | | | | |
| 105 | Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. | | | | | | | | | | | |
| 106 | Recommendations are based upon data size, data distribution, and skewness. | | | | | | | | | | | |
| 107 | These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). | | | | | | | | | | | |
| 108 | However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician. | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **UCL Statistics for Data Sets with Non-Detects** | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | User Selected Options | | | | | | | | | | | |
| 4 | Date/Time of Computation | 5/27/2015 12:26:14 PM | | | | | | | | | | |
| 5 | From File | ProUCL_6J_RE.xls | | | | | | | | | | |
| 6 | Full Precision | OFF | | | | | | | | | | |
| 7 | Confidence Coefficient | 95% | | | | | | | | | | |
| 8 | Number of Bootstrap Operations | 2000 | | | | | | | | | | |
| 9 | **nitrate gw** | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| 11 | **General Statistics** | | | | | | | | | | | |
| 12 | Total Number of Observations | 11 | | | | | Number of Distinct Observations | 11 | | | | |
| 13 | | | | | | | Number of Missing Observations | 0 | | | | |
| 14 | Minimum | 0.39 | | | | | Mean | 22.58 | | | | |
| 15 | Maximum | 62.5 | | | | | Median | 18.1 | | | | |
| 16 | SD | 21.37 | | | | | Std. Error of Mean | 6.442 | | | | |
| 17 | Coefficient of Variation | 0.946 | | | | | Skewness | 0.726 | | | | |
| 18 | | | | | | | | | | | | |
| 19 | **Normal GOF Test** | | | | | | | | | | | |
| 20 | Shapiro Wilk Test Statistic | 0.898 | | | | | **Shapiro Wilk GOF Test** | | | | | |
| 21 | 5% Shapiro Wilk Critical Value | 0.85 | | | | | Data appear Normal at 5% Significance Level | | | | | |
| 22 | Lilliefors Test Statistic | 0.219 | | | | | **Lilliefors GOF Test** | | | | | |
| 23 | 5% Lilliefors Critical Value | 0.267 | | | | | Data appear Normal at 5% Significance Level | | | | | |
| 24 | **Data appear Normal at 5% Significance Level** | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 26 | **Assuming Normal Distribution** | | | | | | | | | | | |
| 27 | **95% Normal UCL** | | | | | | **95% UCLs (Adjusted for Skewness)** | | | | | |
| 28 | 95% Student's-t UCL | 34.26 | | | | | 95% Adjusted-CLT UCL (Chen-1995) | 34.68 | | | | |
| 29 | | | | | | | 95% Modified-t UCL (Johnson-1978) | 34.49 | | | | |
| 30 | | | | | | | | | | | | |
| 31 | **Gamma GOF Test** | | | | | | | | | | | |
| 32 | A-D Test Statistic | 0.362 | | | | | **Anderson-Darling Gamma GOF Test** | | | | | |
| 33 | 5% A-D Critical Value | 0.765 | | | | | Detected data appear Gamma Distributed at 5% Significance Level | | | | | |
| 34 | K-S Test Statistic | 0.178 | | | | | **Kolmogrov-Smirnoff Gamma GOF Test** | | | | | |
| 35 | 5% K-S Critical Value | 0.265 | | | | | Detected data appear Gamma Distributed at 5% Significance Level | | | | | |
| 36 | **Detected data appear Gamma Distributed at 5% Significance Level** | | | | | | | | | | | |
| 37 | | | | | | | | | | | | |
| 38 | **Gamma Statistics** | | | | | | | | | | | |
| 39 | k hat (MLE) | 0.722 | | | | | k star (bias corrected MLE) | 0.586 | | | | |
| 40 | Theta hat (MLE) | 31.28 | | | | | Theta star (bias corrected MLE) | 38.56 | | | | |
| 41 | nu hat (MLE) | 15.88 | | | | | nu star (bias corrected) | 12.88 | | | | |
| 42 | MLE Mean (bias corrected) | 22.58 | | | | | MLE Sd (bias corrected) | 29.51 | | | | |
| 43 | | | | | | | Approximate Chi Square Value (0.05) | 5.815 | | | | |
| 44 | Adjusted Level of Significance | 0.0278 | | | | | Adjusted Chi Square Value | 5.062 | | | | |
| 45 | | | | | | | | | | | | |
| 46 | **Assuming Gamma Distribution** | | | | | | | | | | | |
| 47 | 95% Approximate Gamma UCL (use when n>=50)) | 50.03 | | | | | 95% Adjusted Gamma UCL (use when n<50) | 57.48 | | | | |
| 48 | | | | | | | | | | | | |
| 49 | **Lognormal GOF Test** | | | | | | | | | | | |
| 50 | Shapiro Wilk Test Statistic | 0.856 | | | | | **Shapiro Wilk Lognormal GOF Test** | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 5% Shapiro Wilk Critical Value | | | | | 0.85 | Data appear Lognormal at 5% Significance Level | | | | | |
| 52 | Lilliefors Test Statistic | | | | | 0.181 | **Lilliefors Lognormal GOF Test** | | | | | |
| 53 | 5% Lilliefors Critical Value | | | | | 0.267 | Data appear Lognormal at 5% Significance Level | | | | | |
| 54 | **Data appear Lognormal at 5% Significance Level** | | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| 56 | **Lognormal Statistics** | | | | | | | | | | | |
| 57 | Minimum of Logged Data | | | | | -0.942 | Mean of logged Data | | | | | 2.284 |
| 58 | Maximum of Logged Data | | | | | 4.135 | SD of logged Data | | | | | 1.771 |
| 59 | | | | | | | | | | | | |
| 60 | **Assuming Lognormal Distribution** | | | | | | | | | | | |
| 61 | 95% H-UCL | | | | | 630.1 | 90% Chebyshev (MVUE) UCL | | | | | 96.79 |
| 62 | 95% Chebyshev (MVUE) UCL | | | | | 124.5 | 97.5% Chebyshev (MVUE) UCL | | | | | 162.9 |
| 63 | 99% Chebyshev (MVUE) UCL | | | | | 238.4 | | | | | | |
| 64 | | | | | | | | | | | | |
| 65 | **Nonparametric Distribution Free UCL Statistics** | | | | | | | | | | | |
| 66 | **Data appear to follow a Discernible Distribution at 5% Significance Level** | | | | | | | | | | | |
| 67 | | | | | | | | | | | | |
| 68 | **Nonparametric Distribution Free UCLs** | | | | | | | | | | | |
| 69 | 95% CLT UCL | | | | | 33.18 | 95% Jackknife UCL | | | | | 34.26 |
| 70 | 95% Standard Bootstrap UCL | | | | | 32.59 | 95% Bootstrap-t UCL | | | | | 36.68 |
| 71 | 95% Hall's Bootstrap UCL | | | | | 35.13 | 95% Percentile Bootstrap UCL | | | | | 33.32 |
| 72 | 95% BCA Bootstrap UCL | | | | | 34.77 | | | | | | |
| 73 | 90% Chebyshev(Mean, Sd) UCL | | | | | 41.91 | 95% Chebyshev(Mean, Sd) UCL | | | | | 50.66 |
| 74 | 97.5% Chebyshev(Mean, Sd) UCL | | | | | 62.81 | 99% Chebyshev(Mean, Sd) UCL | | | | | 86.68 |
| 75 | | | | | | | | | | | | |
| 76 | **Suggested UCL to Use** | | | | | | | | | | | |
| 77 | 95% Student's-t UCL | | | | | 34.26 | | | | | | |
| 78 | | | | | | | | | | | | |
| 79 | Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. | | | | | | | | | | | |
| 80 | These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) | | | | | | | | | | | |
| 81 | and Singh and Singh (2003). However, simulations results will not cover all Real World data sets. | | | | | | | | | | | |
| 82 | For additional insight the user may want to consult a statistician. | | | | | | | | | | | |

## UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | 5/27/2015 12:26:14 PM |
| From File | ProUCL_6J_RE.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**nitrite soil**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 22 | Number of Distinct Observations | 21 |
| Number of Detects | 1 | Number of Non-Detects | 21 |
| Number of Distinct Detects | 1 | Number of Distinct Non-Detects | 20 |

**Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!**

**It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).**

**The data set for variable nitrite soil was not processed!**

## UCL Statistics for Data Sets with Non-Detects

| | |
|---|---|
| User Selected Options | |
| Date/Time of Computation | 5/27/2015 12:26:14 PM |
| From File | ProUCL_6J_RE.xls |
| Full Precision | OFF |
| Confidence Coefficient | 95% |
| Number of Bootstrap Operations | 2000 |

**nitrite gw**

### General Statistics

| | | | |
|---|---|---|---|
| Total Number of Observations | 7 | Number of Distinct Observations | 3 |
| Number of Detects | 2 | Number of Non-Detects | 5 |
| Number of Distinct Detects | 2 | Number of Distinct Non-Detects | 1 |
| Minimum Detect | 0.151 | Minimum Non-Detect | 0.1 |
| Maximum Detect | 0.451 | Maximum Non-Detect | 0.1 |
| Variance Detects | 0.045 | Percent Non-Detects | 71.43% |
| Mean Detects | 0.301 | SD Detects | 0.212 |
| Median Detects | 0.301 | CV Detects | 0.705 |
| Skewness Detects | N/A | Kurtosis Detects | N/A |
| Mean of Logged Detects | -1.343 | SD of Logged Detects | 0.774 |

**Warning: Data set has only 2 Detected Values.**

**This is not enough to compute meaningful or reliable statistics and estimates.**